Development of a Method to Analyze and Track Emergent Vegetation Using Remote Sensing (A Case Study in ArcMAP and ENVI)

Term Project

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Table of Contents

INTRODUCTION 3
1.1 Lake Characteristics 3
1.2 Area of Study 4
LITERATURE REVIEW 4
RESEARCH PROCEDURE 5
3.1 ARCMap NDVI Approach 5
3.2 Image Differencing Approach in ENVI 5.0 8
RESULTS 10
CONCLUSION 12
REFERENCES 13

List of Figures

Figure 1: View of Emergent Vegetation on Wetlands around Malheur Lake from Landsat Imagery 3
Figure 2: Display of NDVI method used in Arcmap ModuleBuilder 6
Figure 3: NDVI Output showing Vegetated (Green) areas and non-vegetated (Blue) areas in the Malheur lake watershedin 1995 7
Figure 4: NDVI Output showing Vegetated (Green) areas and non-vegetated (Blue) areas in the Malheur lake watershed in 2000 7
Figure 5: Layout of Data Management in ENVI 9
Figure 6: Image Classification Process in ENVI 9
Figure 7: Classification of the 1995 Landsat image to identify change in Emergent Vegetation on the lake 10
Figure 8: Classification of the 2000 Landsat image to identify change in Emergent Vegetation on the lake 10
Figure 10: Change detection Statistics for difference in lake area for the two years 11
Figure 11: Visual representation of the change detected for emergent vegetation for the two years is indicated with the maroon color 12

INTRODUCTION

Emergent vegetation is an indicator of lake-health for Malheur Lake. Studies indicate that the large carp populations significantly affect emergent vegetation. Thus changes in emergent vegetation can be used as a lake-health indicator and can help assess the impact of various changes and management decisions. I propose to use Landsat data to track emergent vegetation and develop a method to generate annual reports on emergent vegetation extent. Also, the use of change detection algorithms along with these results will be used to quantify changes in vegetated area over time and develop a baseline of emergent vegetation.

Figure 1: View of Emergent Vegetation on Wetlands around Malheur Lake from Landsat Imagery

This work will be done in close collaboration with Malheur Lake Ecologists to determine the appropriate dates, times, and areas for these estimates. Landsat collects data every 16 days, however, to accurately assess emergent vegetation water levels must be low (so that deltas and wetlands are not inundated) and vegetation be actively growing to display an image to the sensor. Sensitive areas will be identified from the area of study.

This report explores other published information on the particular subject matter and presents a case study using the NDVI application and image differencing technique in ENVI to study two years out of the 30 years available data for the study.

1.1 Lake Characteristics

The natural, eutrophic lake has a highly turbid appearance due to activities of the invasive carp population constantly disturbing lake bed sediments. Increasing nutrients build up results in aquatic plants dominating the lake resulting in excessive oxygen supply for the carp. This occurrence damages lake

health after a period and the control of the carp growth is a problem that the Malheur National Wildlife Refuge is concerned with.

1.2 Area of Study

Malheur Lake is located in Harney county, southeastern region of Oregon. The lake empties into a nearby lake, Harney Lake. It covers a 49700 acres area with a surface elevation of 4, 093 feet with inflow sources from the Silvies River and Donner und Blitzen River. The maximum depth of the lake is 5 feet and a volume of 84, 500 acre feet.

LITERATURE REVIEW

NDVI Differencing and Post-classification to Detect Vegetation Changes in Halabja City, Iraq

Al-Doski, Jwan, Shattri B. Mansor, and Helmi Zulhaidi Mohd Shafri. "NDVI Differencing and Post-classification to Detect Vegetation Changes in Halabja City, Iraq." *IOSR Journal of Applied Geology and Geophysics* 1 (): 01-10. Print.

This article uses the NDVI differencing method and post classification methods to detect and quantify vegetation cover change in Halagba city in Iraq. Change detection and NDVI application was performed for images from 1986 to 1990 which is a commonly used change detection technique known as image differencing. For a broader span of time other than two years of data, other techniques will be explored unless an algorithm can be used to apply image differencing for about 30 years of data. It is important to note that this application seemed more effective for regions of high leaf biomass and more of fields, and a section of the article focuses on plant area change around a lake in the area of study. Using the two years studied, a combined analysis is performed showing areas of increase and decrease and no change using a contrast of light and dark throughout the period of study. This result can be useful in the study of a wider study period for Malheur Lake.

NDWI—A normalized difference water index for remote sensing of vegetation liquid water from space

Gao, Bo-Cai. "NDWI—A normalized difference water index for remote sensing of vegetation liquid water from space." *Remote Sensing of Environment* (): 257-266. Print.

Research is done on vegetation covers using two near infra-Red channels, one centered at approximately 0.86 μm and 1.24 μm with a proposed method; the Normalized Difference Water Index (NDWI). It is supposed to be complimentary to the commonly used Normalized Difference Vegetation Index (NDVI) used for remote sensing vegetation. This new method is sensitive to changes in liquid water content of vegetation canopies. The study suggests that the latest Landsat mission which will have available channels as one proposed will be able to more develop the technique. Landsat 8 data will be useful in this research to determine if the new added spectral wavelengths will contribute to our change detection model. For the purposes of this case study, Landsat 5 is used in this case study and other Landsat missions will be explored in the future developments of the research.

RESEARCH PROCEDURE

3.1 ARCMap NDVI Approach

Data layer: The Landsat images are downloaded from the earthexplorer website and the Oregon Spatial Data Library. Three data layer are used which are obtained from the library mentioned above. The Oregon Counties boundaries is used to locate Harney County in relation to where the lake is located, watershed boundaries to identify inlet streams and view and identify any drainage in the area.

Overlay Operation: The clip tool is used to clip the watershed boundaries onto the counties map and the satellite image.

Raster Calculator: This function was used to perform the NDVI equation using the Near Infrared band and Infrared band of the downloaded images.

NDVI = (Near Infrared – Infrared) / (Near Infrared + Infrared)

This application was run in a module builder in Arcmap. The schematic is a simple procedure involving the images used and a raster calculator which displays an output raster as seen in Figure 3.

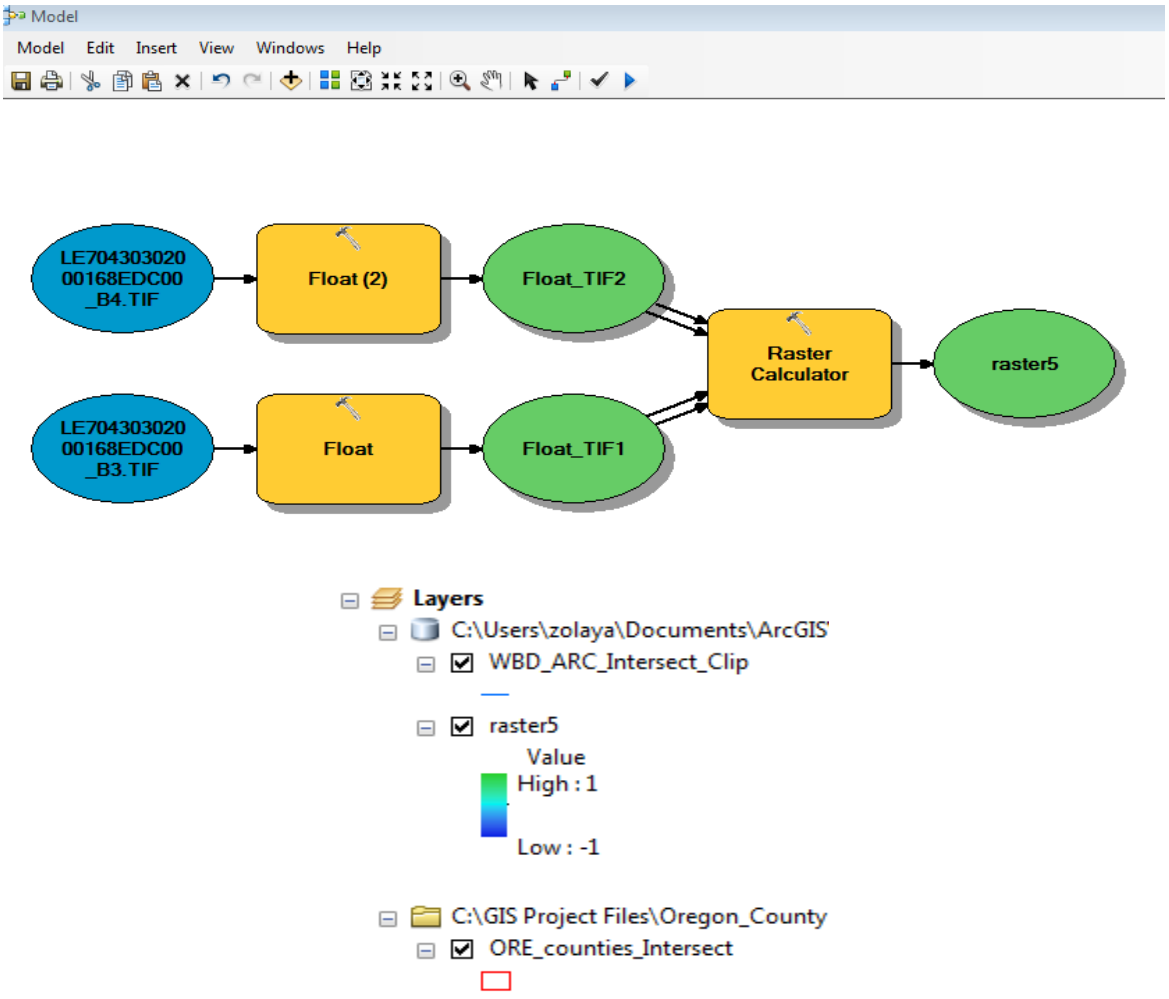

Figure 2: Display of NDVI method used in Arcmap ModuleBuilder

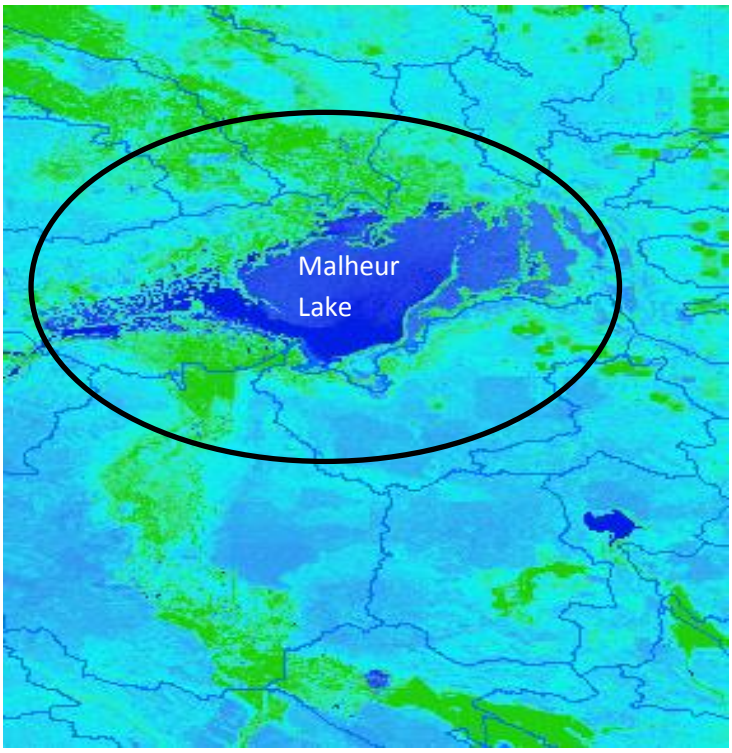

Figure 3: NDVI Output showing Vegetated (Green) areas and non-vegetated (Blue) areas in the Malheur lake watershedin 1995

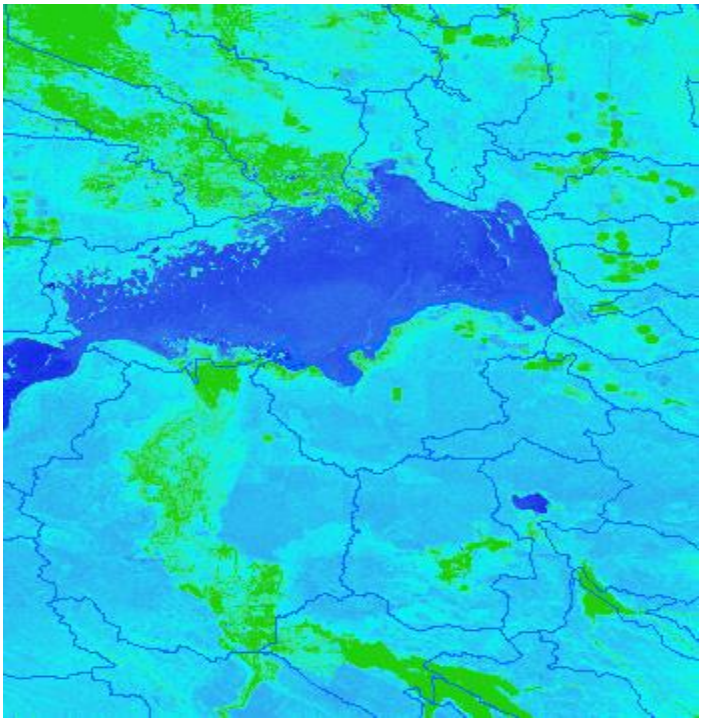

Figure 4: NDVI Output showing Vegetated (Green) areas and non-vegetated (Blue) areas in the Malheur lake watershed in 2000

NDVI is a method that is widely used to estimate plant production by classifying areas that are barren and vegetated area. This approach did not seem too effective for the extent to which change had to be located in emergent vegetation on the Lake. It will be more applicable to large scale plant mapping, like cultivated areas within a radius around the lake rather than identifying very discrete regions such as areas on the lake over time. The other setback with this method is the difficulty to estimate quantitatively the amount of change that has occurred. A future development to this project will be to use a tool in ArcMap to calculate the area change or proportion of change from the initial state to the final. Other Vegetation Indices for water will be applied in the future to determine whether more accurate results will be obtained. The next approach focused on using the image differencing technique using ENVI.

3.2 Image Differencing Approach in ENVI 5.0

Layer Stacking: The Red Green and Blue false colors were used combined as a composite band to enhance areas where water is located. This corresponds to Bands 2, 3 and 4.

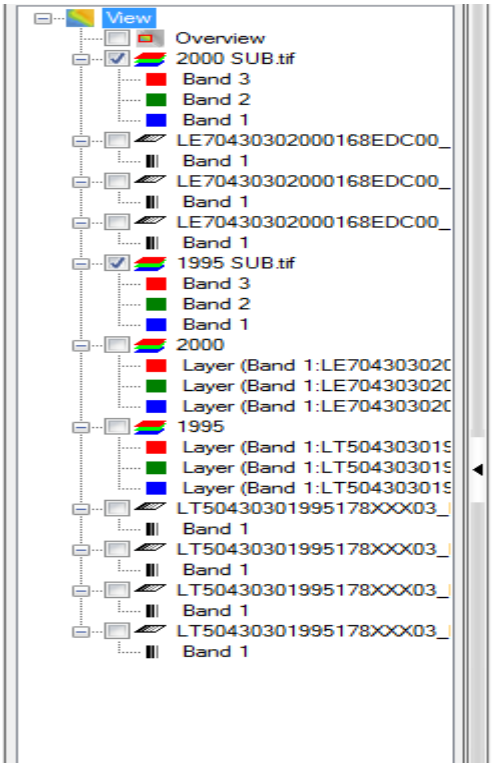

Figure 5: Layout of Data Management in ENVI

The composite band was then converted into a tiff file and this step was done for both years. The extent of area of interest which is the lake region was resized. The Unsupervised IsoData Classification was used.

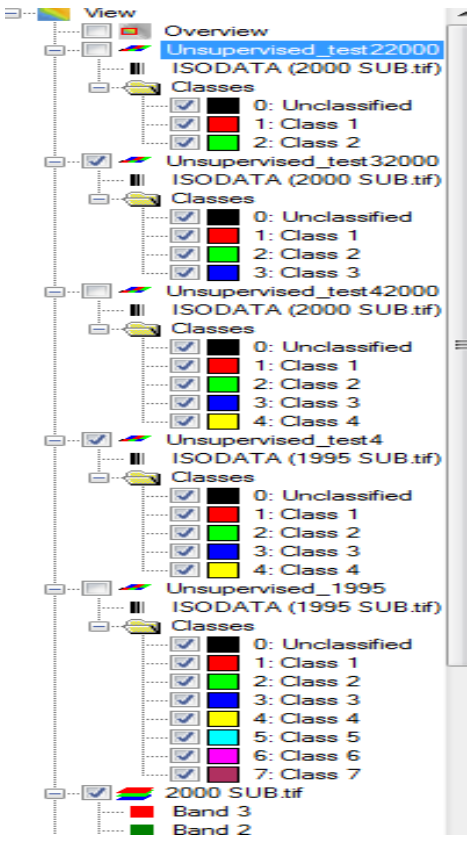

Figure 6: Image Classification Process in ENVI

Several classes were adjusted to determine the areas that showed the vegetation on the lake the best. Four classes were sufficient for the year 2000 and 7 classes were used for 1995. See diagram below in Figure 5 above.

RESULTS

In 1995, the classification is symbolized as follows, yellow as high density Vegetation, Green representing normal vegetation, blue as barren and red water. See Figure 6.

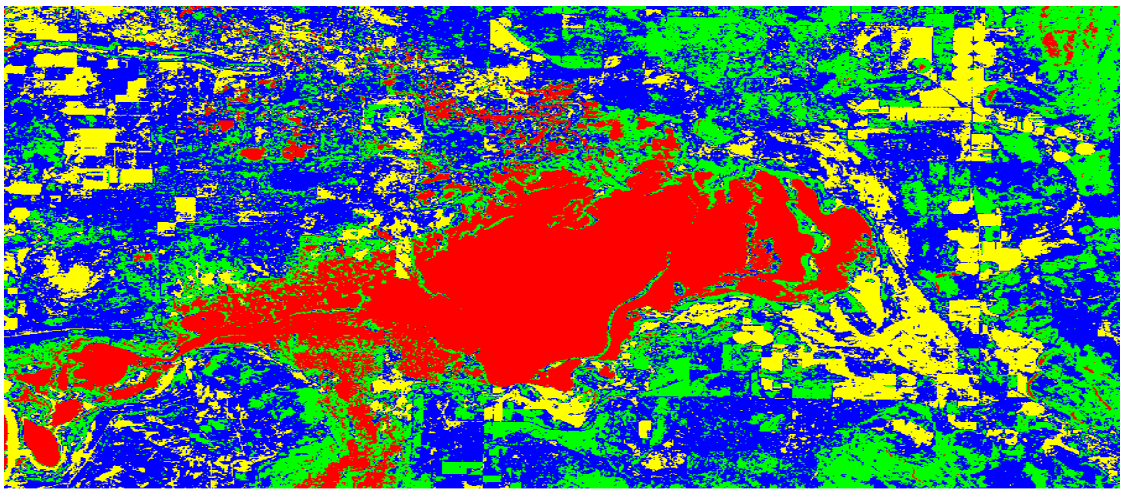

Figure 7: Classification of the 1995 Landsat image to identify change in Emergent Vegetation on the lake

For the 2000 image, fewer classes had to be used in order to obtain better detail of what each color symbolized. In comparison to the former processed year, 1995, the area of water on the lake increased as compared to 1995 where there seem to be a drought occurring.

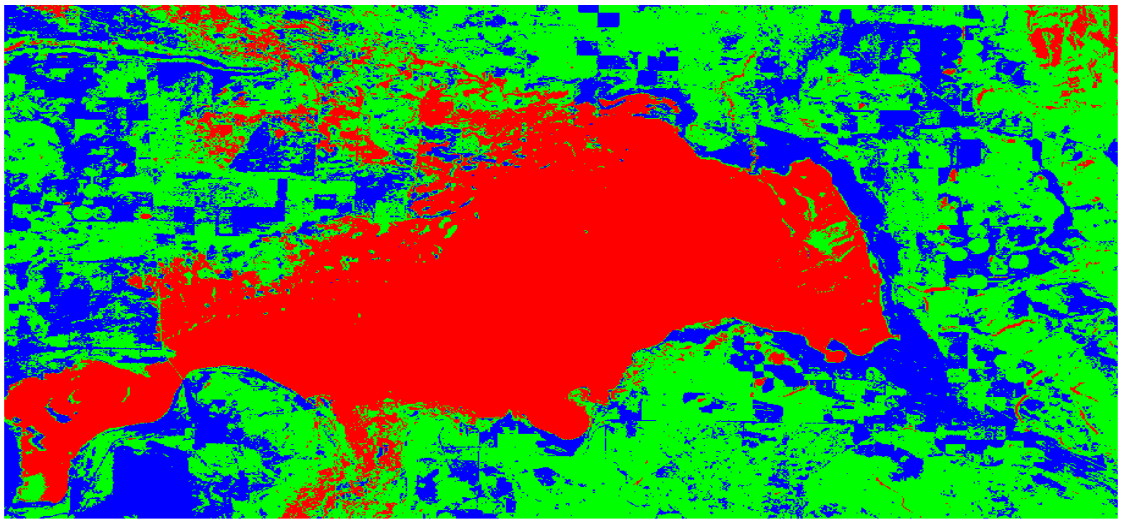

Figure 8: Classification of the 2000 Landsat image to identify change in Emergent Vegetation on the lake

From the images, there is also evidence that in 1995, there is the presence of more vegetation on the lake than in 2000.

The next step was to perform a Change detection Statistics to quantitatively measure the area of change. It is important to also note that the change detected can be represented as a pixel count or percentage as well. This is performed using the Change Detection Statistic tool as seen in Figure 8.

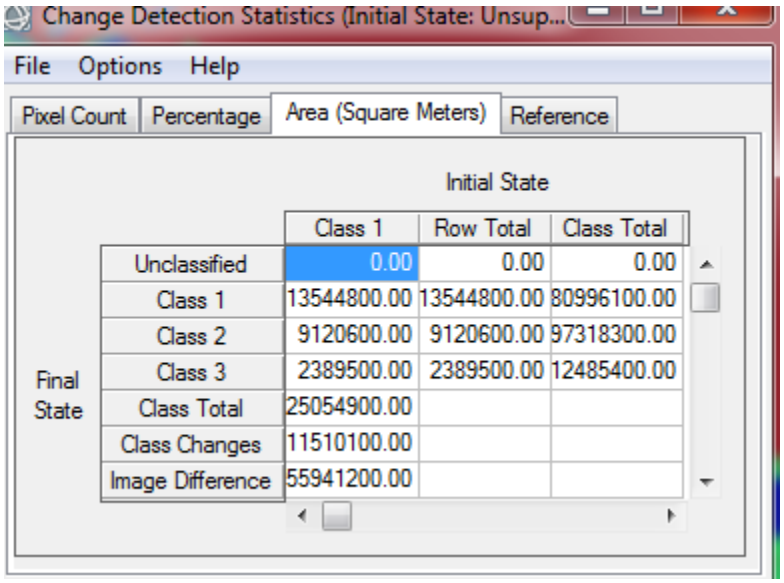

Figure 9: Change detection Statistics for difference in lake area for the two years

The similar class for both years representing the lake was matched, which is Class 1. The resulting difference or change that occurred between the initial state of the lake in 1995 and 2000 was recorded to be 55941200 square meters (See Figure 8).

A Thematic Change Detection Workflow was used to produce a graphical representation of the change in Vegetation on the lake. The areas that appear in the maroon color depict areas of vegetation change on the lake.

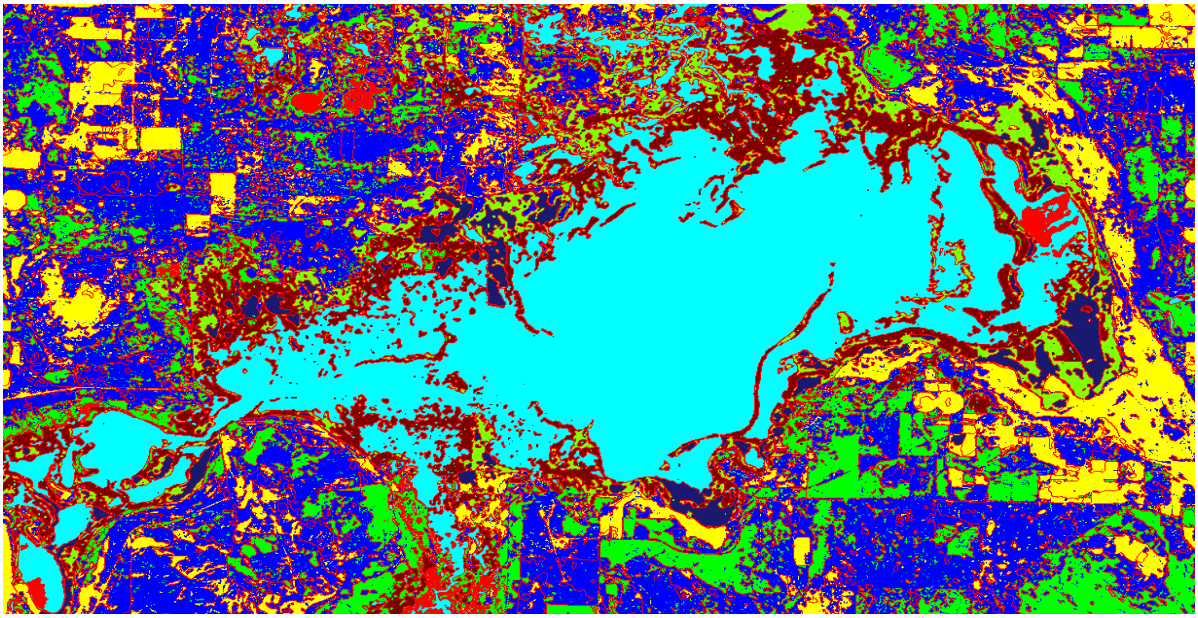

Figure 10: Visual representation of the change detected for emergent vegetation for the two years is indicated with the maroon color

CONCLUSION

There has been a significant increase in the vegetation over the 5 years period and it will be an interesting study to detect the changes that have occurred in the intermediate years and a longer duration. I prefer the Change detection method through classification in ENVI as compared to the NDVI approach. Implementing a variety of classes helps to ranks the magnitude of biomass growing on and around the lake. Whereas, a two sided contrast of positive and negative change does not completely answer the question under investigation. Raster Analysis in ENVI using the Classification and Change detection statistics tools will be a starter for this research project, as this case study has proved so.

REFERENCES

Al-Doski, Jwan, Shattri B. Mansor, and Helmi Zulhaidi Mohd Shafri. "NDVI Differencing and Post-classification to Detect Vegetation Changes in Halabja City, Iraq." *IOSR Journal of Applied Geology and Geophysics* 1 (): 01-10. Print.

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